APPROVED FOR PUBLIC RELEASE
DISTRIBUTION UNLIMITED

AFPTEF REPORT NO. 08-R-08
AFPTEF PROJECT NO. 06-P-106

MATTHEW P. BOZZUTO
Project Engineer
matthew.bozzuto@wpafb.af.mil
DSN 787-7166
Comm (937) 257-7166

SUSAN J. EVANS
Qualification Test Engineer
susan.evans@wpafb.af.mil
DSN 787-7445
Comm (937) 257-7445

Development of the MQ-9 Reaper Wings Container CNU-699/E

403 SCMS/GUEB
AIR FORCE PACKAGING TECHNOLOGY & ENGINEERING FACILITY
WRIGHT PATTERSON AFB, OH 45433-5540
3 June 2008

AFPTEF PROJECT NO. 06-P-106
TITLE: Development of the MQ-9 Reaper Wings Container

ABSTRACT

The Air Force Packaging Technology & Engineering Facility (AFPTEF) was tasked with the design of a new shipping and storage container for the MQ-9 Reaper wings in March of 2006. The previous container did not adequately satisfy user needs and Air Force requirements. A main problem was that it was designed for an MQ-9 Reaper fuselage, wings, and tails combined, which exceeded the 10,000 lb Air Force requirement for available ground support equipment. AFPTEF designed a smaller container for only the wings and tails and a separate container for the fuselage in order to bring container weights down under the 10,000 lb upper limit. Both containers feature retractable casters for rapid C-130 deployment and easier handling. The wings container features a wire rope isolator mounted cradle system to protect the wings and tails (20G fragility). The design reduces required ground support equipment and eliminates hoisting risk to the wings by allowing wing jack usage for loading/unloading the wings.
The new container, CNU-699/E, designed with SAE ARP1967A, is an aluminum, long-life, controlled breathing, reusable shipping and storage container. CNU-699/E protects the MQ-9 Reaper wings and tails mechanically and environmentally and has passed all qualification tests per ASTM D4169.

Total man-hours: 1800

PROJECT ENGINEER:

Matthew P. Bozzuto
Mechanical Engineer
AFPTEF

TEST ENGINEER:

Susan J. Evans
Mechanical Engineer
AFPTEF

APPROVED BY:

Robbin L. Miller
Chief, Air Force Packaging
Technology & Engineering
Facility

PUBLICATION DATE:

3 JUNE 2008

TABLE OF CONTENTS

APPENDICES

INTRODUCTION

BACKGROUND – The MQ-9 Reaper fuselage, wings, and tails were shipped and stored in a single fiberglass container that required a forklift with greater than 10k rated capacity. This was a main problem due to limited availability of ground support equipment (GSE) at some operating locations. The Air Force requirement was that the MQ-9 Reaper containers be able to be handled by a forklift with a common 10k rated lift capacity. This prompted the MQ-9 Reaper program office and AFPTEF to develop a new family of containers for storage and transportation of the MQ-9 Reaper fuselage, wings and tails, propeller, and QEC engine. In addition to meeting weight requirements, it was an opportunity to expand and enhance the capabilities and functionality of the containers to better facilitate the Air Force users.

REQUIREMENTS – AFPTEF and the MQ-9 Reaper program office at Wright-Patterson AFB and General Atomics agreed upon a list of requirements. The requirements are as follows:

- Sealed/controlled-breathing container that protects against varied environmental conditions and weather during either inside or outside shipping and storage
- Aluminum construction
- Weight under 10,000 lb
- Fuselage shock/vibration limited to 20 Gs
- Retractable caster system
- Transportable on current C-130 aircraft
- Accommodate both wings, both diagonal tails, and the vertical tail.
- Reusable and designed for long life (20 years)
- Low maintenance
- Field repairable hardware
- Forklift capabilities

DEVELOPMENT

DESIGN – The MQ-9 Reaper wings shipping and storage container (CNU-699/E) design (Appendix 2, Figures 1, 2, & 3) meets all the users' requirements. The CNU-699/E is a sealed, welded aluminum, controlled breathing, reusable container. The container is engineered for the physical and environmental protection of the wings and tails during worldwide transportation and storage. The container consists of a base (Appendix 2, Figures 2 & 3), wings and tails cradle mounting system, and completely removable cover equipped with the special features listed below.
The base is a one piece skid/double walled base extrusion with forklift openings, humidity indicator, pressure equalizing valve (1.0 psi pressure/ 1.0 psi vacuum), and desiccant port for easy replacement of desiccant (controls dehumidification). The extrusions that make up the base of this container and the ones integrated into the cover are new designs that maintain the usability and functionality of standard base designs but are stiffer in all directions. A silicone rubber gasket and quick release cam-over-center

latches create a water/air-tight seal at the base-cover interface. The cover is removable with built in and fully enclosed forklift pockets. During cover removal, four corner guide posts keep the cover away from the wings and tails. These fold down to facilitate wings and tails loading/unloading. The wings are positioned with the bottom of each wing facing the outside of the container (Appendix 2, Figure 2) to allow use of wing jacks (Appendix 2, Figure 11), which is a new container capability that allows each wing to be removed from the container and installed on the aircraft with the same piece of ground support equipment.

The cradle is designed to support each of the two wings at three locations along the wing surface and one location on a wing spar, each of the two diagonal tails at two locations along the tail surface and one location on a wing spar, and the vertical tail in a foam lined aluminum box. The cradle is suspended in the base by eight stainless steel wire rope coil isolators that protect the wings and tails, keeping the response from shock and vibration below the 20G fragility requirement.

Each wing surface support location fully encloses the wing with foam lined and partially removable structures that are secured by cam buckle straps. There are three basic components at each of the wing surface support locations: a lower section that the wing is lowered into (Appendix 2, Figure 14) with the wing jacks, an adjustable inner A-frame support (Appendix 2, Figure 15), and a removable L-frame support (Appendix 2, Figure 16) that is held in place with a cam buckle strap (Appendix 2, Figure 17). The wing spar support has a post that interfaces with the spar pin holes; the spar is also tied down with a cam buckle strap (Appendix 2, Figure 18).

The diagonal tails and the vertical tail are positioned in the center of the cradle between the two wings (Appendix 2, Figures 12 & 13). Similar to the spar supports used for the wings, tail spar holes interface with a post and are held in place by cam buckle straps (Appendix 2, Figure 19). Two of the three A-frame wing supports have a secondary purpose to capture the diagonal tails which pass through the center of them (Appendix 2, Figure 20). These two A-frames open in the center and are removable in order to access and remove the diagonal tails. The foam lined aluminum box that encloses the vertical tail closes securely with a cam over center latch (Appendix 2, Figure 21).

For rapid C-130 deployment capability, a retractable caster system was developed so that the container could roll onto a C-130 then, subsequently, since the container is narrow enough for a walkway along the side, the casters could be retracted to either set the container on blocks or lower the container directly onto the floor of the aircraft. This system was designed to operate under the full load of the container weight without any external lifting device. (Appendix 2, Figures 9 & 10)

Container external dimensions are 430.0 inches length, 59.0 inches width, and 76.8 inches height (88.8 inches with casters lowered). Container empty weight is 5550 pounds and 6750 pounds with the wings and tails in place.

MQ-9 REAPER WINGS CONTAINER FEATURES	
Pressure Equalizing Valve	4
Humidity Indicator	1
Desiccant Port	1
Document Receptacle	None
Forkliftable	Yes
Cover Latches	58
Cover Lift Handles	None
Cover Lift Rings	None
Cover Tether Rings	None
Base Lift Handles	None
Base Tie-down Rings	20
Stacking Capability	No

PROTOTYPE – One exterior container was prototyped for testing the fuselage and wing configurations. AFPTEF retrofitted the fuselage prototype container (CNU-697/E) and transformed it into the wings prototype container (CNU-699/E) for testing. The interior cradle and mounting system was fabricated in house. The prototype container was fabricated in accordance with (IAW) all requirements and tolerances of the container drawing package. The drawing package used for prototype fabrication has been released for the manufacture of production quantities of the container. Each face of the container was uniquely identified for testing identification as shown below.

DESIGNATED SIDE	CONTAINER FEATURE
Top	Cover Top
Aft	Desiccant Port
Right	Right Side from Aft
Left	Left Side from Aft
Forward	Opposite Aft
Bottom	Base Bottom

QUALIFICATION TESTING

TEST LOAD – One set of non-repairable wings and tails (Appendix 2, Figures 2 & 3) comprised the test load. The wings and tails were mounted in the support cradle as for transportation. A vertical tail was not available for testing so an appropriate amount of weight was placed in the vertical tail enclosure instead. The test load weight was 1200 pounds.

TEST PLAN – The test plan primary references were ASTM D 4169 and SAE ARP 1967 (Appendix 1). The test methods specified in this test plan constituted the procedure for performing the tests on the container. The performance criteria for evaluation of container acceptability were specified at 20 Gs maximum and an initial and final leak rate of 0.05 psi per hour at 1.0 psi. These tests are commonly applied to special shipping containers providing rough handling protection to sensitive items. The tests were performed at AFPTEF, Building 91, Area C, Wright-Patterson AFB.

ITEM INSTRUMENTATION – The test load was instrumented with a piezoelectric triaxial accelerometer (Appendix 2, Figure 4). Since the cradle is designed for multiple items, the accelerometer was mounted on the horizontal face of the central cradle support beam, directly below the test mass center of gravity of the system. This was done instead of instrumenting any one or multiple items. Accelerometer axis orientations were as follows:

X Axis - Directed through container Forward and Aft (desiccant port) sides.
Y Axis - Directed through container Left and Right sides.
Z Axis - Directed through container Top and Bottom sides (vertical motion).

See Appendix 4 for detailed information on the accelerometer and other instrumentation.

TEST SEQUENCES – Note: All test sequences were performed at ambient temperature and humidity, unless otherwise noted in the test procedure.

TEST SEQUENCE 1 – Leak Test

Procedure – The desiccant port cover was removed and replaced with a port cover modified for attachment of the digital manometer and vacuum/pressure pump lines. The container was closed and sealed. The leak test was conducted at ambient temperature and pressure. The pneumatic pressure leak technique was used to pressurize the container to a minimum test pressure of 1.0 psi. Maximum allowable leak rate is 0.05 psi per hour. (Appendix 2, Figure 5).

Results – This test was performed once, prior to the start of fuselage configuration testing with this container. The test could not be performed because during fuselage configuration testing, welds on the tie down ring mounts failed as a result of a fabrication error. The ring mount welds were not completed in accordance with the drawing package. The weld failure caused the ring mounts to bend and crack the container wall, which caused leaks. The container passed the leak test prior to all testing with a leak rate less than the maximum allowed rate of 0.05 psi per hour.

TEST SEQUENCE 2 – Vacuum Retention Test

Procedure – The desiccant port cover was removed and replaced with a port cover modified for attachment of the digital manometer and vacuum/pressure pump lines. The container was closed and sealed. The vacuum retention test was conducted at ambient temperature and pressure. The air inside the container was evacuated to a minimum vacuum of -1.0 psi. Maximum allowable pressure increase rate is 0.05 psi per hour. (Appendix 2, Figure 5).

Results – This test was performed once, prior to the start of fuselage configuration testing with this container. The container passed the vacuum retention test prior to all testing with a pressure increase rate less than the maximum allowed rate of 0.05 psi per hour.

TEST SEQUENCE 3 – Rotational Drops

Procedure – A drop height of 12 inches was used to perform four corner and four edge drops onto a smooth concrete surface, and the impact levels were recorded. The maximum allowed impact level for the item was 20 Gs. (Appendix 2, Figures 6, 7, & 8)

Results – All of the recorded impact peak G data (filtered) was less than the maximum allowed 20 Gs. The accelerometer's location on the cradle support beam resulted in the recording of excessive noise (ringing) for each impact, which severely obscured the impact waveform. All waveform data, therefore, was filtered at frequencies ranging from 100 Hz to 152 Hz as appropriate for that waveform. The filter frequency for each complex shock pulse was conservatively calculated as 10 times the base frequency of the shock pulse. There was no damage to either the container or the test mass due to the impacts. The container met the test requirements. (Appendix 3, Table 1 and Waveforms.)

TEST SEQUENCE 4 – Leak Test

Procedure – Repeat Test Sequence 1.

Results – As described in Test Sequence 1, this test could not be performed.

TEST CONCLUSIONS – No damage was caused by the above testing to the container, isolation system or test item. All impact levels were below the item fragility limit of 20Gs. Therefore, the container and mounting system do provide adequate protection for the wings and tails.

FIT & FUNCTION TESTING

Fit and function testing for the wings and tails was completed on site at General Atomics' facility in Palmdale, CA. A production set of wings and tails was loaded into the container cradle and checked for fit. (Appendix 2, Figure 11, 12, & 13)
Since a C-130 loading test was performed on site at Wright-Patterson AFB for the fuselage container, which is the identical exterior container and weighs more, the test was not performed again for the wing configuration. The C-130 loading test for the fuselage container consisted of loading the container, with fuselage mass simulator in place, into an actual C-130 with a typical interior configuration. The loaded container was rolled up the aircraft ramp and onto the aircraft by winching. After successful loading, the

retractable caster system was used to lower the container onto blocking and bracing. It was then unloaded in reverse order. (Appendix 2, Figures 9 & 10)

CONCLUSIONS

No damage occurred as a result of the above testing to the container, mounting system or test load. There was no evidence of any contact or impact between the test load, cradle, container walls, or cover. All impact levels are below the item fragility limit of 20 G's. The CNU-699/E aluminum container was accepted by the Predator Program Office at Wright-Patterson AFB. The container met all the user's requirements. The container can protect a set of MQ-9 Reaper wings and tails during world-wide transportation and storage and will likely save the Air Force tens of thousands of dollars in O&M costs.

RECOMMENDATIONS

AFPTEF recommends that new containers be procured immediately and delivered to avoid damage to MQ-9 Reaper wings and tails currently in the logistics cycle, thus mitigating overall shipping risks. All fiberglass containers for the MQ-9 Reaper should be replaced. New containers should be procured as needed.

APPENDIX 1: Test Plan

AF PACKAGING TECHNOLOGY AND ENGINEERING FACILITY (Container Test Plan)

AFPTEF PROJECT NUMBER: 06-P-106

CONTAINER SIZE (L x W x D) (IN) INTERIOR:	EXTERIOR:	WEIGHT (LB) GROSS:	ITEM:	CUBE (CU. FT)	QUANTITY:	DATE:
425 X 54 X 72.5	430 X 59 X 76.8	6750	1200	1127.6	1	19 Dec 07

ITEM NAME: MQ-9 Reaper Wings Container

MANUFACTURER:

CONTAINER NAME: Reusable Shipping & Storage Container

CONTAINER COST:

PACK DESCRIPTION: Extruded Aluminum Cntr., Aluminum Cradle, Test Load of Reaper Wings and Tails

CONDITIONING: As noted below

TEST NO.	REF STD/SPEC AND TEST METHOD OR PROCEDURE NO'S	TEST TITLE AND PARAMETERS	CONTAINER ORIENTATION	INSTRU-MENTATION
		NOTE No damage to contents is acceptable and Package must be in serviceable condition. Serviceable means remains sealed, with no deformities, etc.		
		Quality Conformance Tests		
1.	**Examination of Product.** **SAE ARP 1967 Par. 4.5.1 Table I**	Container shall be carefully examined to determine conformance with material, workmanship, and requirements as specified in Table and drawings.	Ambient temp.	Visual Inspection (VI)
2.	**Weight Test.** **SAE ARP 1967 Par. 4.5.8.3.7**	Container shall be weighed.	Ambient temp.	Scale

COMMENTS:

PREPARED BY: Matthew P. Bozzuto, Mechanical Engineer

APPROVED BY: Robbin L. Miller, Chief AFPTEF

AF PACKAGING TECHNOLOGY AND ENGINEERING FACILITY
(Container Test Plan)

AFPTEF PROJECT NUMBER: 06-P-106

CONTAINER SIZE (L x W x D) (IN) INTERIOR:	EXTERIOR:	WEIGHT (LB) GROSS:	ITEM:	CUBE (CU. FT)	QUANTITY:	DATE:
425 X 54 X 72.5	430 X 59 X 76.8	6750	1200	1127.6	1	19 Dec 07

ITEM NAME: MQ-9 Reaper Wings Container

MANUFACTURER:

CONTAINER NAME: Reusable Shipping & Storage Container

CONTAINER COST:

PACK DESCRIPTION: Extruded Aluminum Cntr., Aluminum Cradle, Test Load of a Reaper Wings and Tails

CONDITIONING: As noted below

TEST NO.	REF STD/SPEC AND TEST METHOD OR PROCEDURE NO'S	TEST TITLE AND PARAMETERS	CONTAINER ORIENTATION	INSTRU-MENTATION
		Performance Tests		
3.	**Leak Test.** **SAE ARP 1967 Par. 4.5.2.1**	Pneumatic pressure at 1.0 psi and vacuum retention at 1.0 psi. After temperature stabilization, pressure drop shall not exceed 0.05 psi per hour. Perform leak test again at end of test series.	Ambient temp.	Pressure Transducer (PT)
4.	**Rotational Drop Tests (Ambient Temperature).** **SAE ARP 1967A Par. 4.5.3 ASTM D4169 ASTM D6179 Methods A&B**	Drop height shall be 12". Item shall not sustain more than 20G's.	Ambient temp. One drop on all bottom corners (4 drops) and one drop on all edges (4 drops).	VI Tri-axial Accelerometer

COMMENTS:

PREPARED BY: Matthew P. Bozzuto, Mechanical Engineer

APPROVED BY: Robbin L. Miller, Chief AFPTEF

PAGE 2 OF 2

APPENDIX 2: Fabrication & Testing Photographs

Figure 1. Closed container with casters extended.

Figure 2. Container base with test wings and tails secured.

Figure 3. Container base with right test wing and diagonal tails secured (left wing and vertical tail removed)

Figure 4. Placement of primary accelerometer on the central cradle support beam (looking down from above).

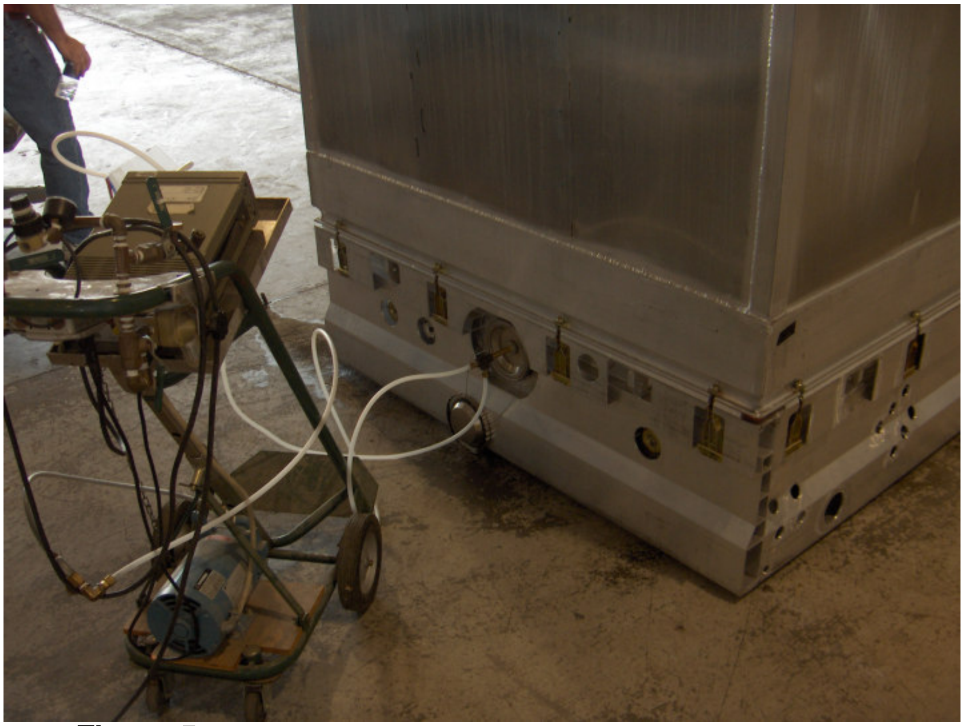


Figure 5. Pressure test set-up (for both pressure and vacuum).

Figure 6. Rotational corner drop (view from aft end).

Figure 7. Rotational corner drop (view from fwd end).

Figure 8. Rotational edge drop.

Figure 9. Container being winched up the C-130 ramp.

Figure 10. Container loaded on the C-130.

Figure 11. Wing jacks lowering a right production wing into the container base.

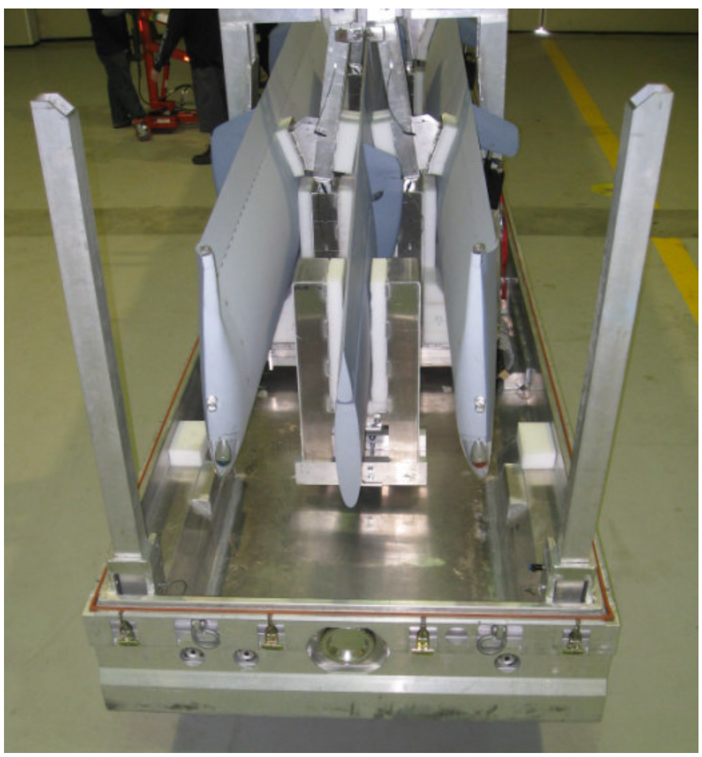


Figure 12. Container base loaded with production wings and tails (aft end).

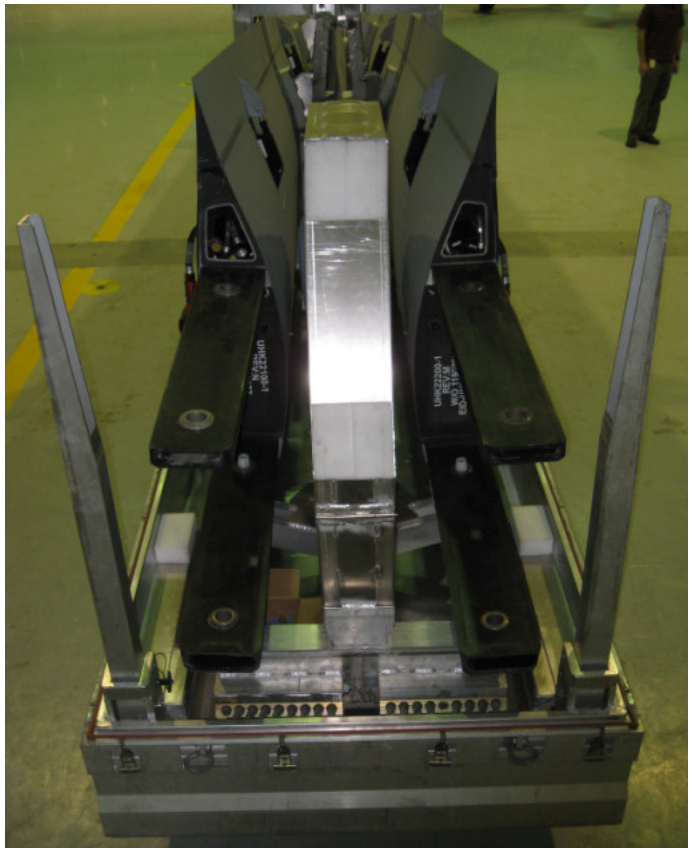


Figure 13. Container base loaded with production wings and tails (fwd end).

Figure 14. Lower wing cushion (white) and helical coil shock isolator.

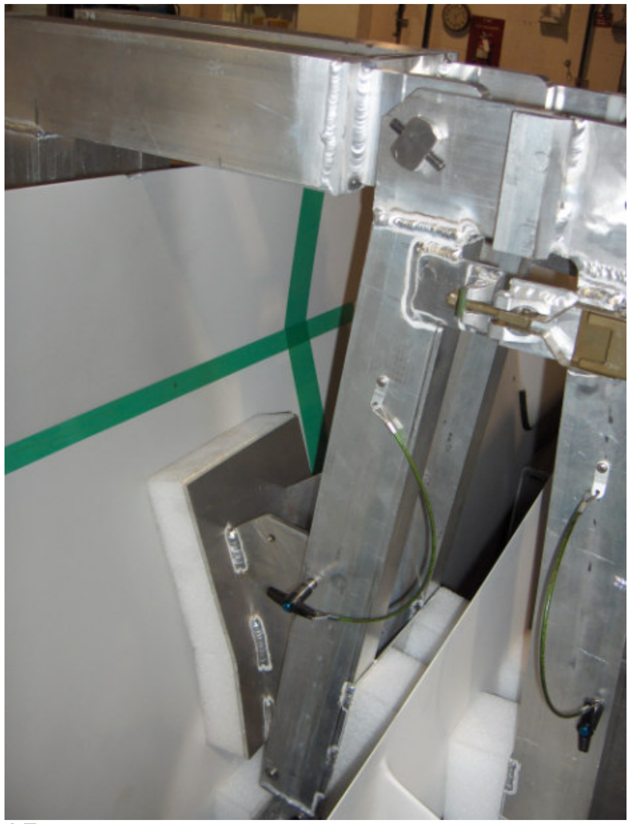


Figure 15. Adjustable inner A-frame support (removable type).

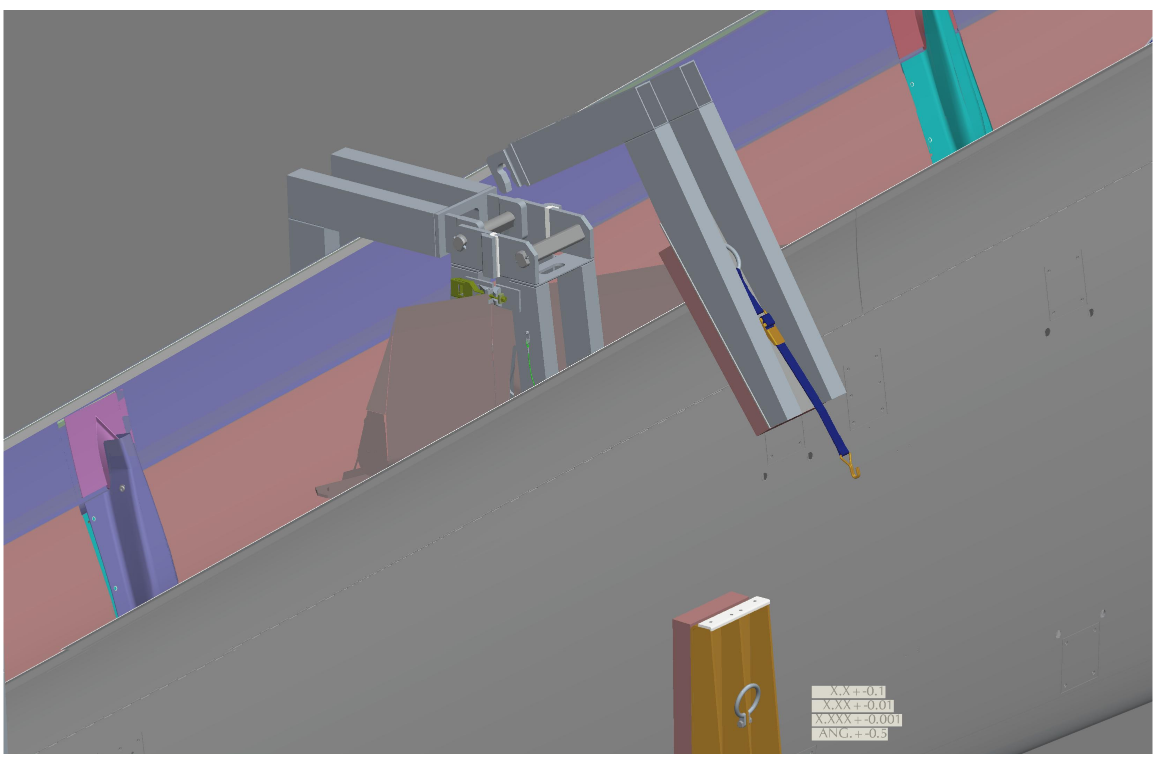


Figure 16. L-frame shown in open and removed position (CAD rendered).

Figure 17. Cam buckle strap for L-frame tie down (1 of 6).

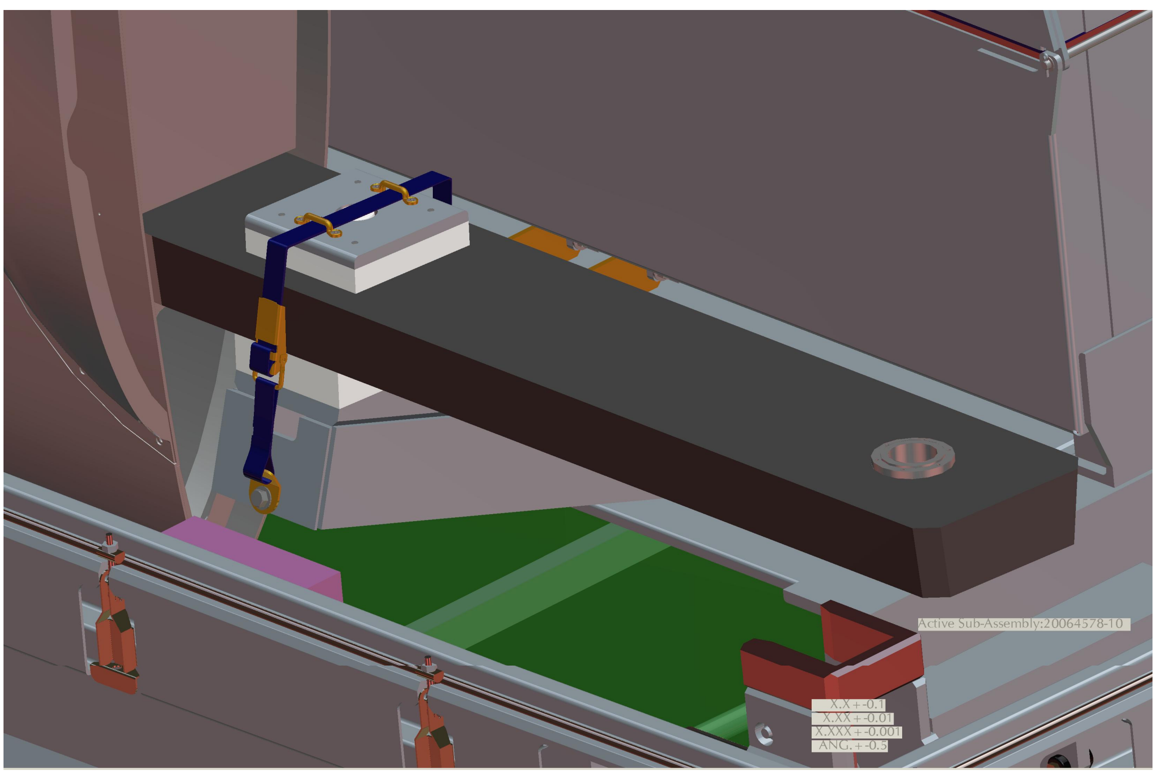


Figure 18. Wing spar tie down point (CAD rendered).

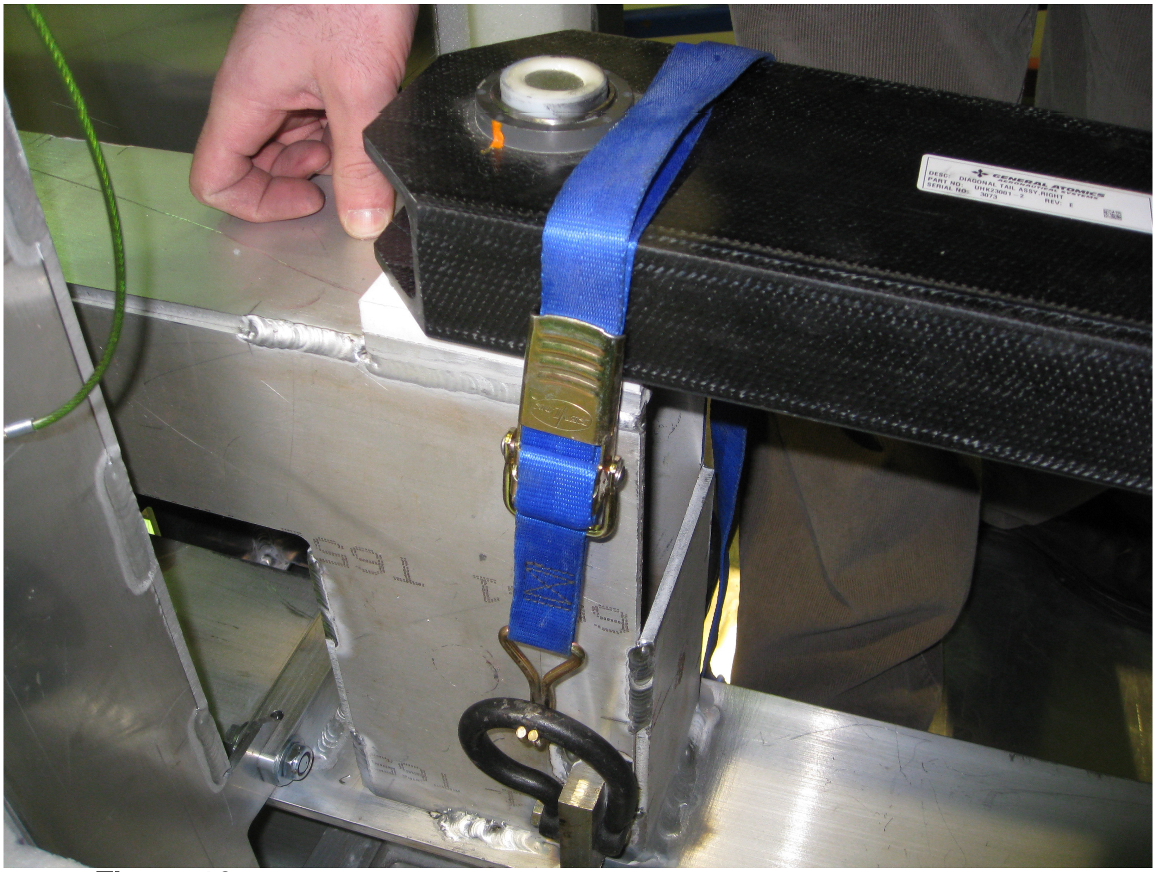


Figure 19. Diagonal tail spar tie down point (shown with production tail).

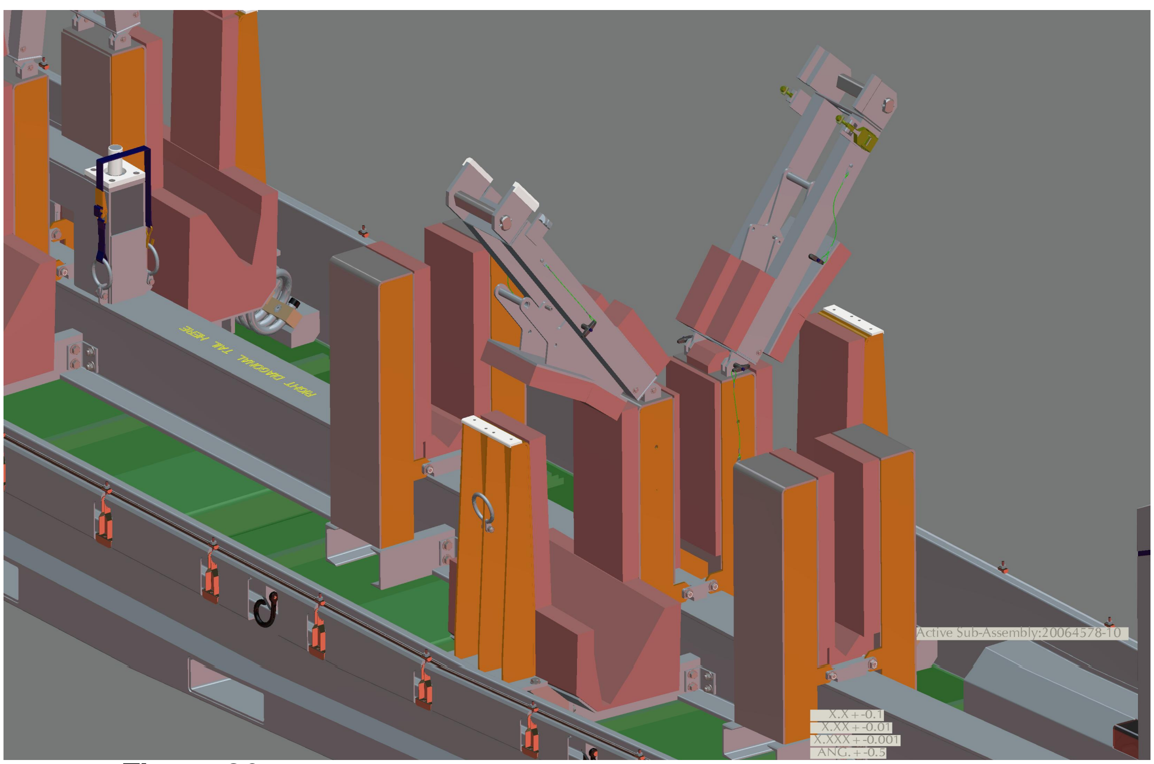


Figure 20. Fwd A-frame shown in the open position (CAD rendered).

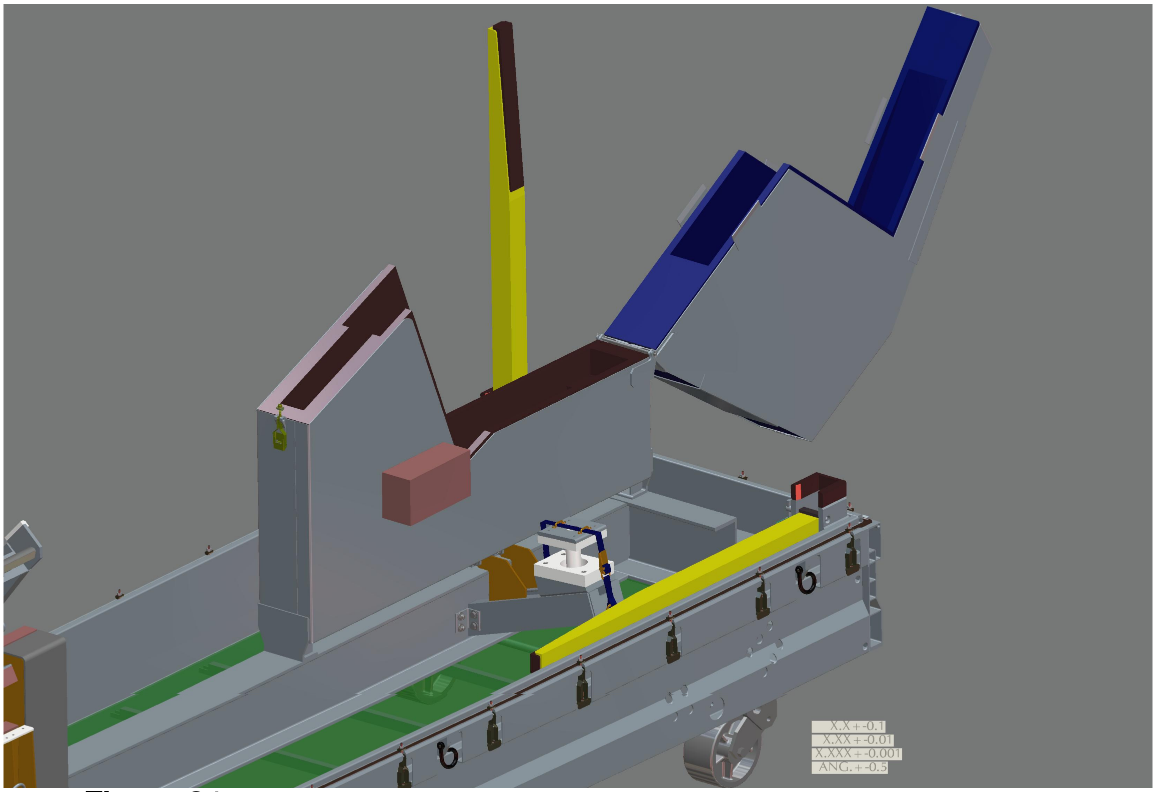


Figure 21. Vertical tail box shown open with tail removed (CAD rendered).

APPENDIX 3: Test Data

Table 1. Reaper Wings Impact Test Summary (filtered data)

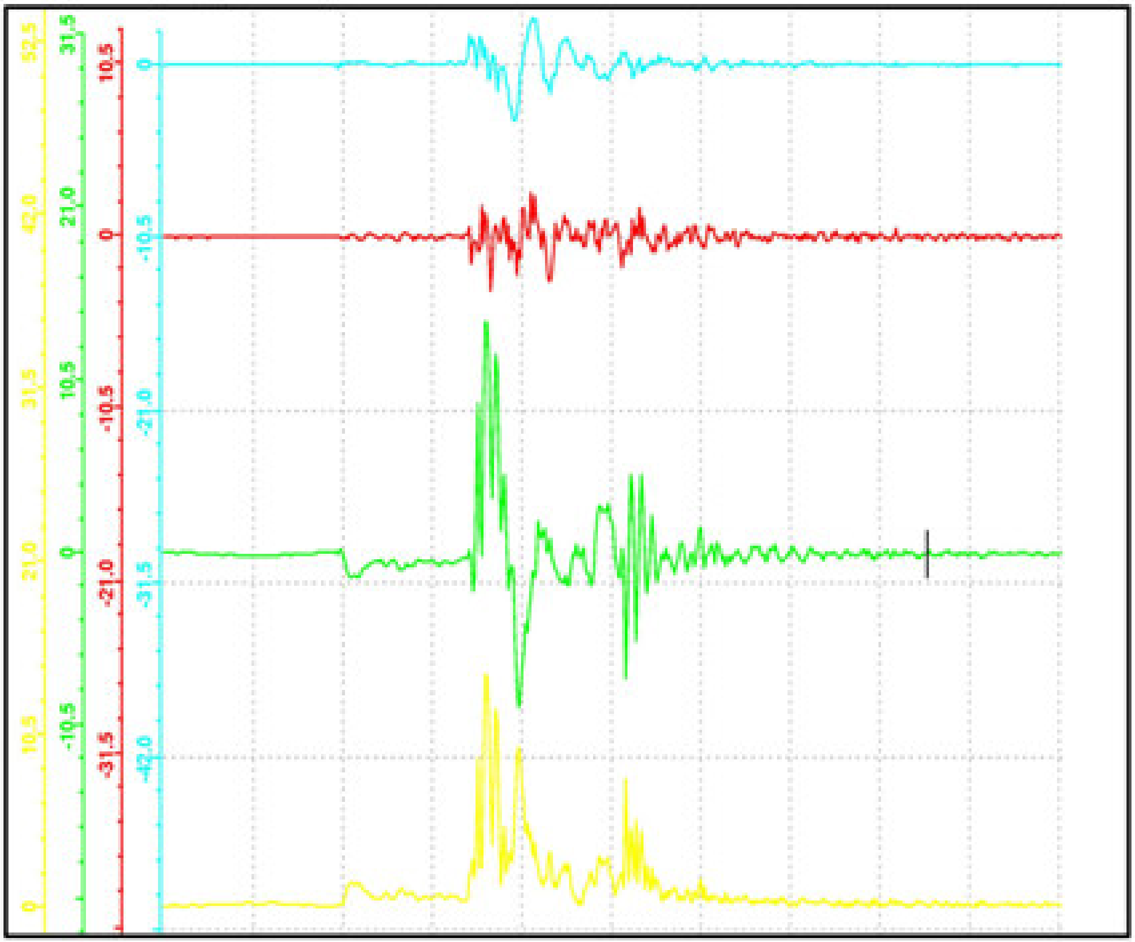
IMPACT TYPE	TEST TEMPERATURE	IMPACT LOCATION	RESULTANT PEAK G
ROTATIONAL - EDGE	ambient	forward-bottom	14
ROTATIONAL - EDGE	ambient	aft-bottom	11
ROTATIONAL - EDGE	ambient	left-bottom	6
ROTATIONAL - EDGE	ambient	right-bottom	11
ROTATIONAL - CORNER	ambient	forward-left	13
ROTATIONAL - CORNER	ambient	forward-right	14
ROTATIONAL - CORNER	ambient	aft-left	9
ROTATIONAL - CORNER	ambient	aft-right	8

REAPER WINGS

ROTATIONAL DROP TEST

Time:	Dec 19 2007 9:47	Test Engineer:	Evans
Test Type:	Edge	Impact Point:	Forward edge
Container/Item:	Reaper Wings	Drop Height:	12 inches

V. Angle: 81.81;H.Angle: 290.14;   Filter: =   100 Hz



Ch.	Time	Curr Amp	Peak Amp	1st Int	Time/Div	Hexp	Vexp
1	1.11 S	0.02 g's	-3.51 g's	10.95 In/s	131 mS	1	2
2	1.11 S	0.05 g's	-3.67 g's	-29.72 In/s	131 mS	1	2
3	1.11 S	-0.14 g's	14.21 g's	-44.16 In/s	131 mS	1	2
R	1.11 S	0.15 g's	14.22 g's	54.35 In/s	131 mS	1	2

Remarks

PEAK Gs X: 4   Y: 4   Z: 14   Peak Gs Resultant: 14.   Filtered at 100 Hz.
Accelerometer on center beam of cradle.
Ch.1=X(forward-aft); Ch.2=Y(left-right); Ch.3=Z(vertical).
Ch4=Resultant.

Aft Side = desiccant port end.   Ambient temperature/humidity.
ASTM D4169, ASTM D6179.   SAE ARP 1967.   Accel. S/N 16473.

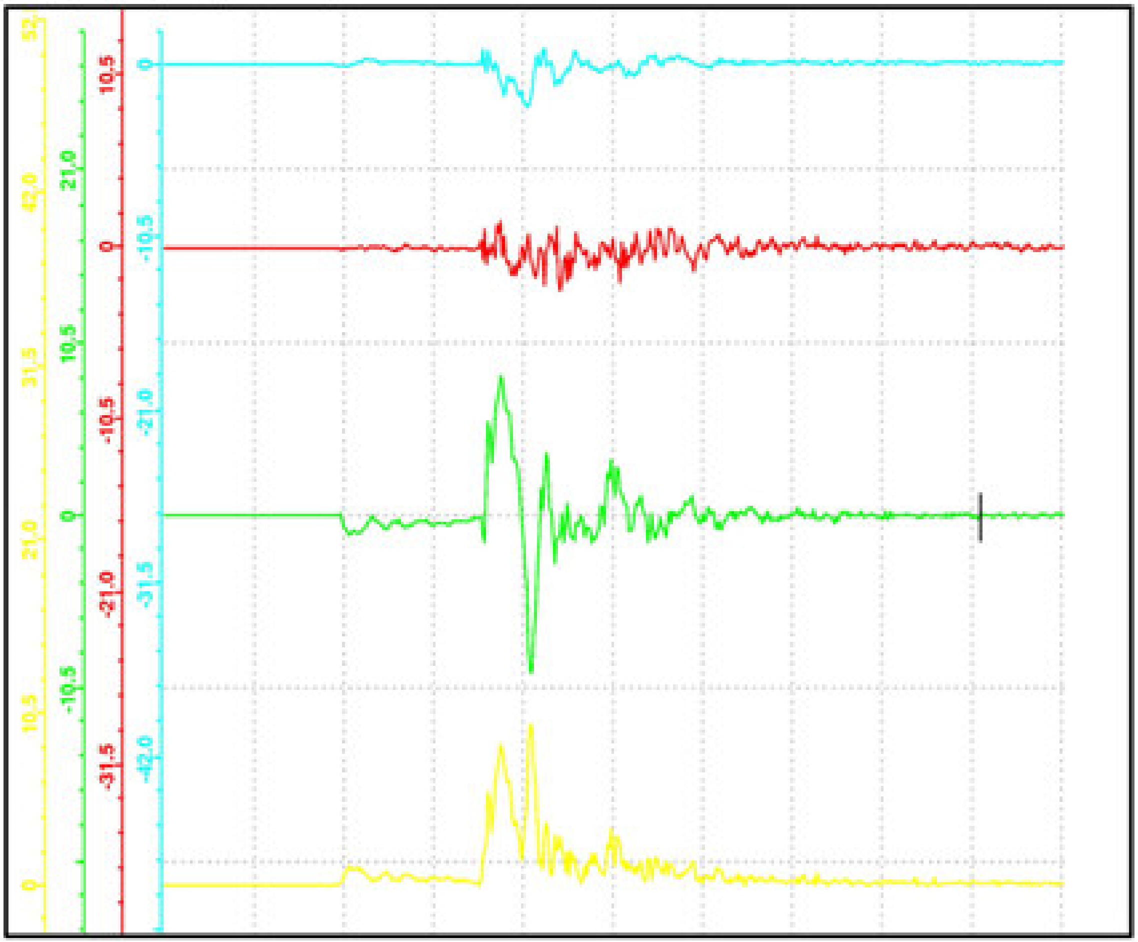
GHI SYSTEMS, INC. CAT SYSTEM

REAPER WINGS

ROTATIONAL DROP TEST

Time:	**Dec 19 2007 12:47**	**Test Engineer:**	**Evans**
Test Type:	**Edge**	**Impact Point:**	**Aft edge**
Container/Item:	**Reaper Wings**	**Drop Height:**	**12 inches**

V. Angle: 47.51;H.Angle: 313.39; Filter: = 120 Hz



Ch.	Time	Curr Amp	Peak Amp	1st Int	Time/Div	Hexp	Vexp
1	1.19 S	0.08 g's	-3.10 g's	-15.87 In/s	131 mS	1	2
2	1.19 S	0.06 g's	-2.97 g's	-19.07 In/s	131 mS	1	2
3	1.19 S	-0.07 g's	-10.41 g's	14.76 In/s	131 mS	1	2
R	1.19 S	0.13 g's	10.66 g's	28.87 In/s	131 mS	1	2

Remarks

PEAK Gs X: 3 Y: 3 Z: 10 Peak Gs Resultant: 11. Filtered at 120 Hz.
Accelerometer on center beam of cradle.
Ch.1=X(forward-aft); Ch.2=Y(left-right); Ch.3=Z(vertical).
Ch4=Resultant.

Aft Side = desiccant port end. Ambient temperature/humidity.
ASTM D4169, ASTM D6179. SAE ARP 1967. Accel. S/N 16473.

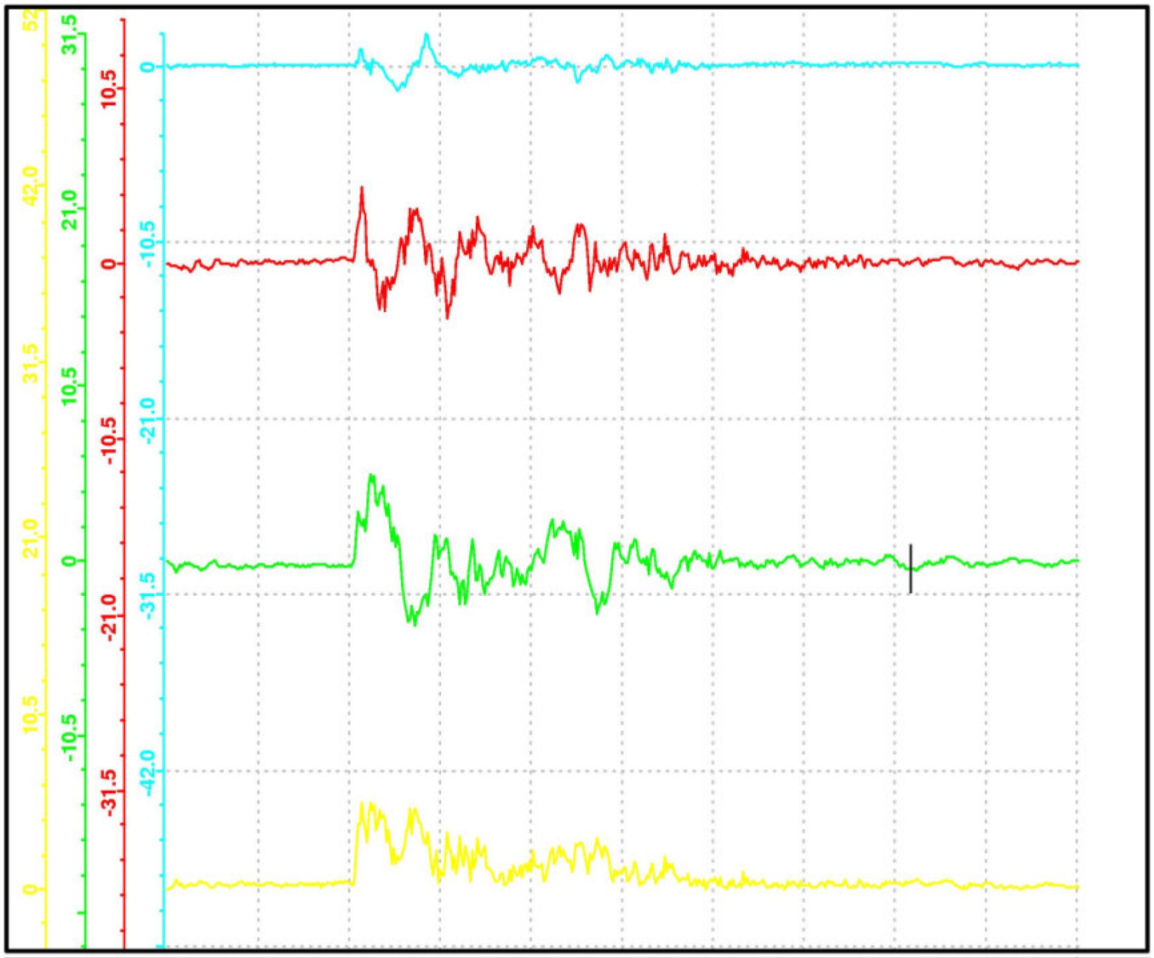
GHI SYSTEMS, INC. CAT SYSTEM

REAPER WINGS

ROTATIONAL DROP TEST

Time:	Dec 19 2007 13:07	Test Engineer:	Evans
Test Type:	Edge	Impact Point:	Left edge
Container/Item:	Reaper Wings	Drop Height:	12 inches

V. Angle: 68.22;H.Angle: 297.33; Filter: = 152 Hz



Ch.	Time	Curr Amp	Peak Amp	1st Int	Time/Div	Hexp	Vexp
1	1.07 S	0.20 g's	2.18 g's	35.90 In/s	131 mS	1	2
2	1.07 S	0.23 g's	5.24 g's	122.68 In/s	131 mS	1	2
3	1.07 S	-0.44 g's	5.52 g's	-17.42 In/s	131 mS	1	2
R	1.07 S	0.53 g's	5.78 g's	129.01 In/s	131 mS	1	2

Remarks

PEAK Gs X: 2 Y: 5 Z: 6 Peak Gs Resultant: 6. Filtered at 152 Hz.
Accelerometer on center beam of cradle.
Ch.1=X(forward-aft); Ch.2=Y(left-right); Ch.3=Z(vertical).
Ch4=Resultant.

Aft Side = desiccant port end. Ambient temperature/humidity.
ASTM D4169, ASTM D6179. SAE ARP 1967. Accel. S/N 16473.

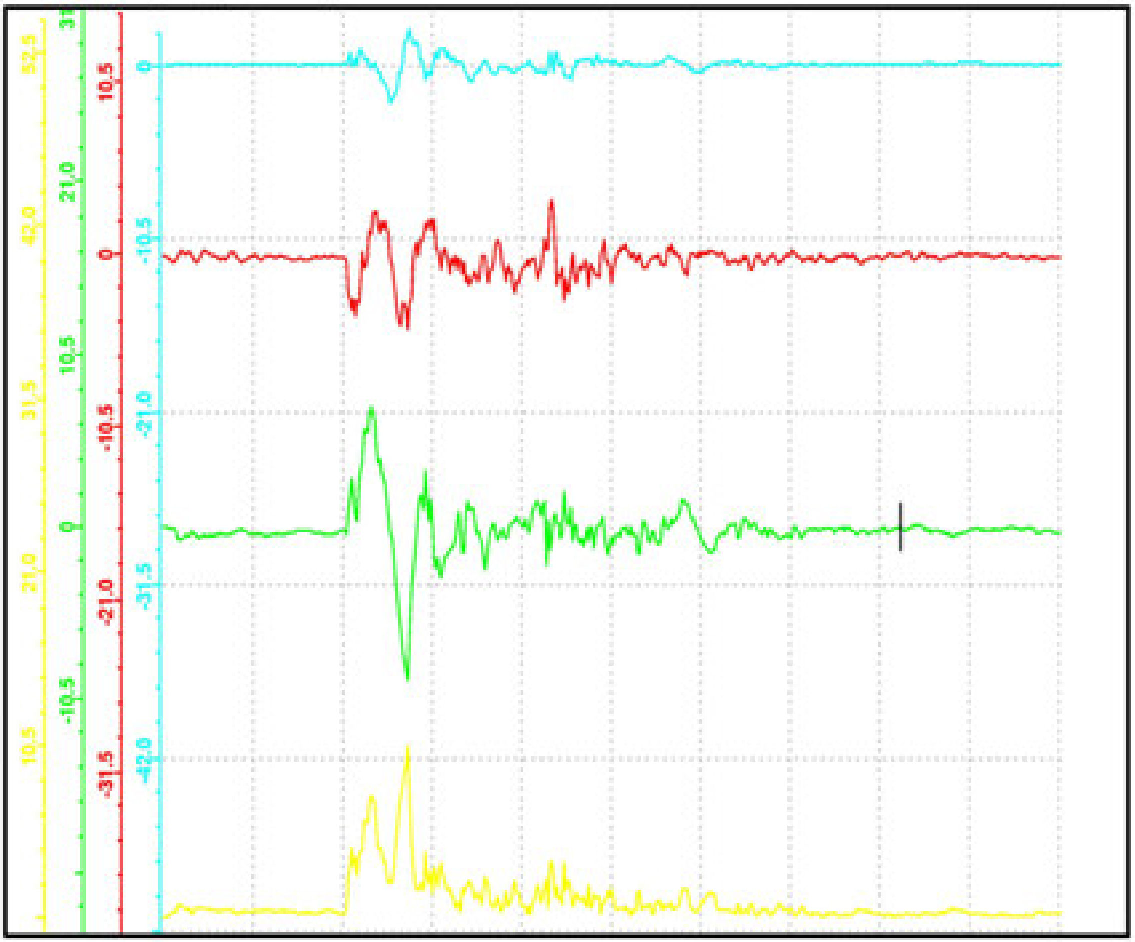
GHI SYSTEMS, INC. CAT SYSTEM

REAPER WINGS

ROTATIONAL DROP TEST

Time:	**Dec 19 2007 13:22**	**Test Engineer:**	**Evans**
Test Type:	**Edge**	**Impact Point:**	**Right edge**
Container/Item:	**Reaper Wings**	**Drop Height:**	**12 inches**

V. Angle: 17.40;H.Angle: 301.87; Filter: = 100 Hz



Ch.	Time	Curr Amp	Peak Amp	1st Int	Time/Div	Hexp	Vexp
1	1.08 S	0.13 g's	2.50 g's	38.19 In/s	131 mS	1	2
2	1.08 S	0.02 g's	-4.72 g's	-93.90 In/s	131 mS	1	2
3	1.08 S	-0.03 g's	-9.26 g's	-76.93 In/s	131 mS	1	2
R	1.08 S	0.13 g's	10.52 g's	127.26 In/s	131 mS	1	2

Remarks

PEAK Gs X: 3 Y: 5 Z: 9 Peak Gs Resultant: 11. Filtered at 100 Hz.
Accelerometer on center beam of cradle.
Ch.1=X(forward-aft); Ch.2=Y(left-right); Ch.3=Z(vertical).
Ch4=Resultant.

Aft Side = desiccant port end. Ambient temperature/humidity.
ASTM D4169, ASTM D6179. SAE ARP 1967. Accel. S/N 16473.

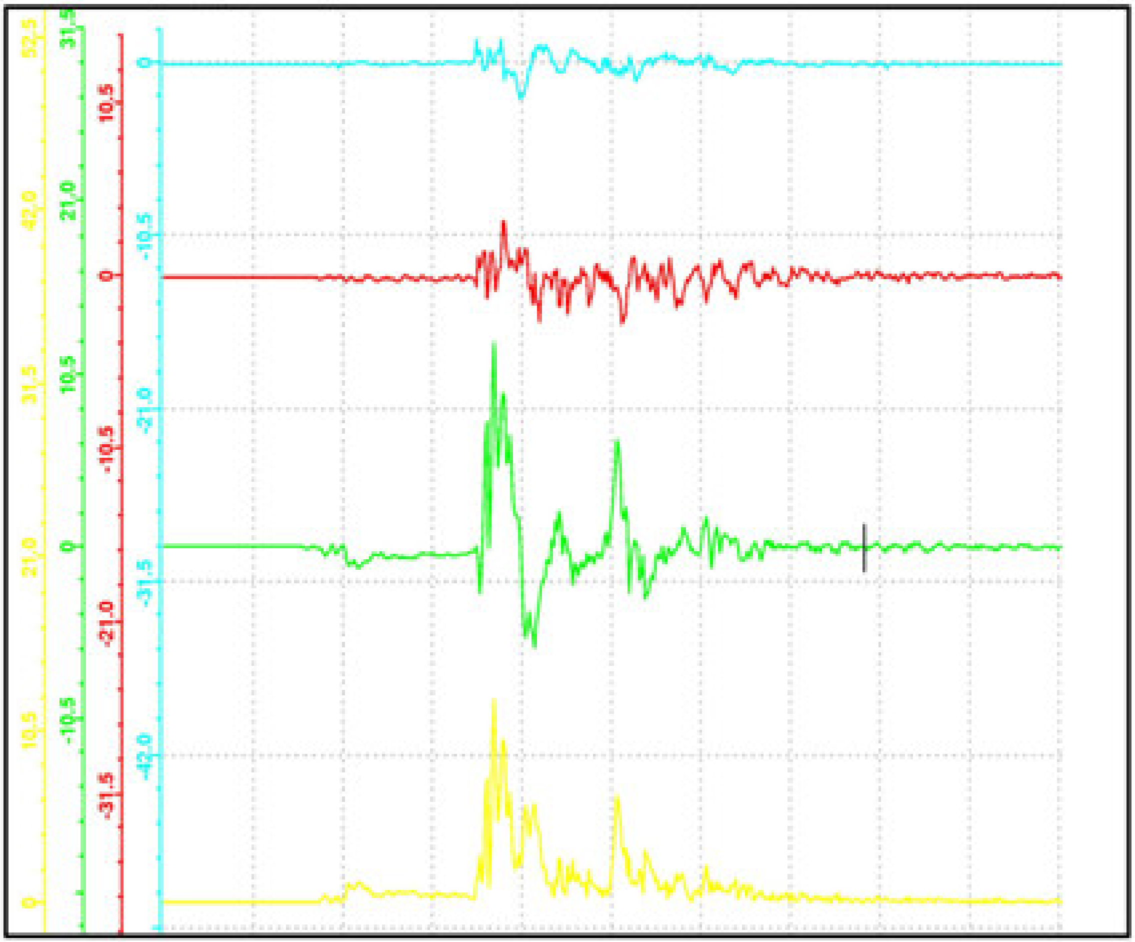
GHI SYSTEMS, INC. CAT SYSTEM

REAPER WINGS

ROTATIONAL DROP TEST

Time:	Dec 19 2007 12:38	Test Engineer:	Evans
Test Type:	Corner	Impact Point:	Forward left corner
Container/Item:	Reaper Wings	Drop Height:	12 inches

V. Angle: 81.44;H.Angle: 327.30; Filter: = 100 Hz



Ch.	Time	Curr Amp	Peak Amp	1st Int	Time/Div	Hexp	Vexp
1	1.02 S	0.02 g's	-2.32 g's	-1.60 In/s	131 mS	1	2
2	1.02 S	0.09 g's	4.68 g's	-23.70 In/s	131 mS	1	2
3	1.02 S	-0.06 g's	12.47 g's	11.39 In/s	131 mS	1	2
R	1.02 S	0.11 g's	12.55 g's	26.35 In/s	131 mS	1	2

Remarks

PEAK Gs X: 2 Y: 5 Z: 12 Peak Gs Resultant: 13. Filtered at 100 Hz.
Accelerometer on center beam of cradle.
Ch.1=X(forward-aft); Ch.2=Y(left-right); Ch.3=Z(vertical).
Ch4=Resultant.

Aft Side = desiccant port end. Ambient temperature/humidity.
ASTM D4169, ASTM D6179. SAE ARP 1967. Accel. S/N 16473.

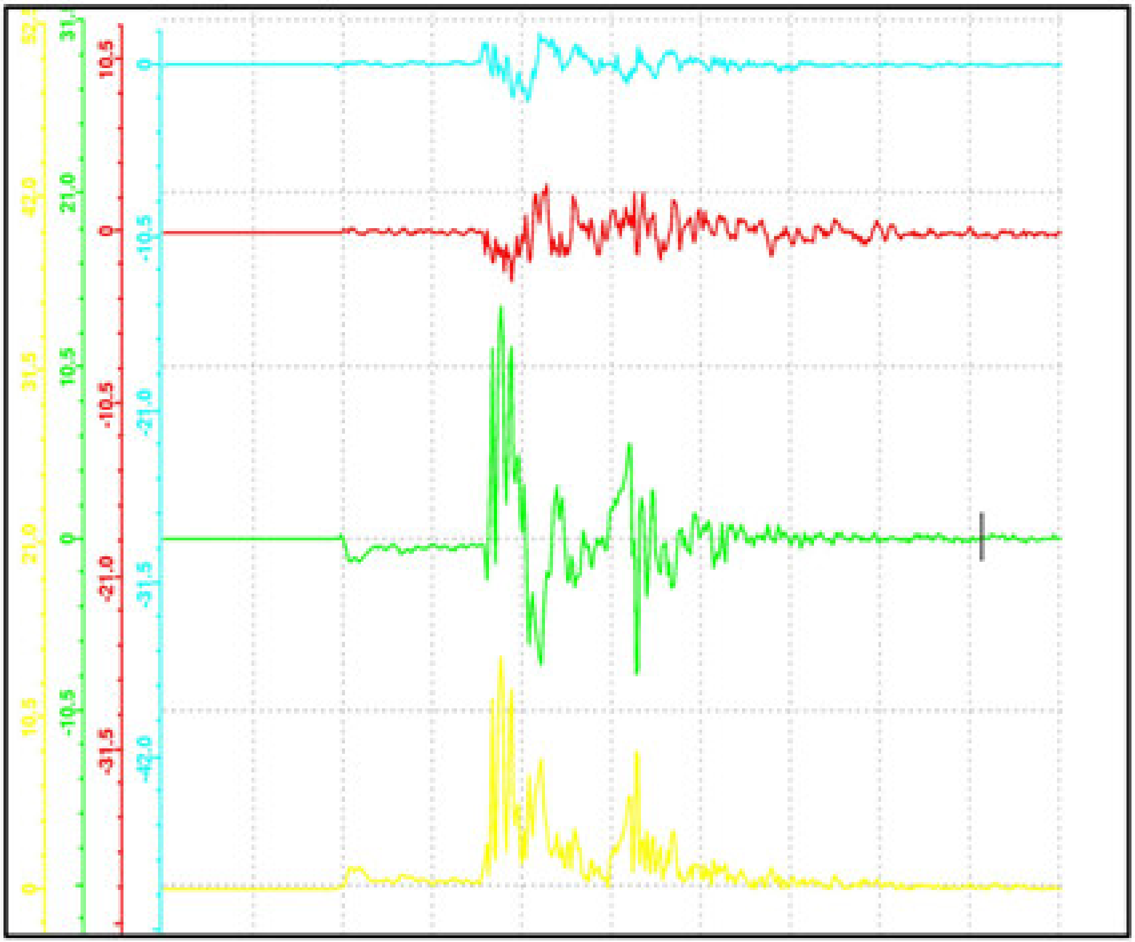
GHI SYSTEMS, INC. CAT SYSTEM

REAPER WINGS

ROTATIONAL DROP TEST

Time:	**Dec 19 2007 9:56**	**Test Engineer:**	**Evans**
Test Type:	**Corner**	**Impact Point:**	**Forward right corner**
Container/Item:	**Reaper Wings**	**Drop Height:**	**12 inches**

V. Angle: 96.85;H.Angle: 155.79;   Filter: =   110 Hz



Ch.	Time	Curr Amp	Peak Amp	1st Int	Time/Div	Hexp	Vexp
1	1.19 S	-0.02 g's	3.33 g's	10.83 In/s	131 mS	1	2
2	1.19 S	-0.12 g's	5.29 g's	17.61 In/s	131 mS	1	2
3	1.19 S	0.05 g's	14.17 g's	9.05 In/s	131 mS	1	2
R	1.19 S	0.13 g's	14.24 g's	22.57 In/s	131 mS	1	2

Remarks

PEAK Gs X: 3   Y: 5   Z: 14   Peak Gs Resultant: 14. Filtered at 110 Hz.
Accelerometer on center beam of cradle.
Ch.1=X(forward-aft); Ch.2=Y(left-right); Ch.3=Z(vertical).
Ch4=Resultant.

Aft Side = desiccant port end. Ambient temperature/humidity.
ASTM D4169, ASTM D6179. SAE ARP 1967. Accel. S/N 16473.

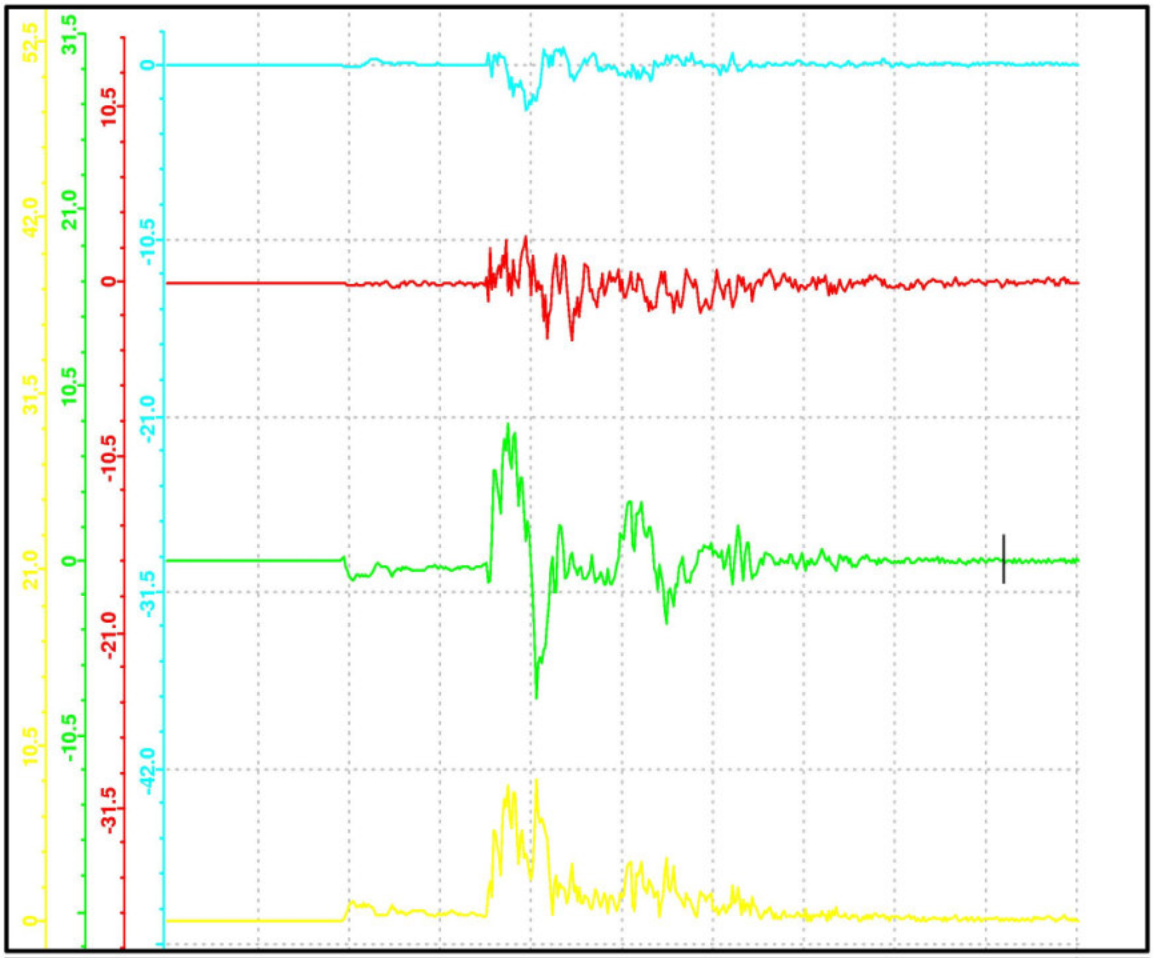
GHI SYSTEMS, INC. CAT SYSTEM

REAPER WINGS

ROTATIONAL DROP TEST

Time:	**Dec 19 2007 12:53**	**Test Engineer:**	**Evans**
Test Type:	**Corner**	**Impact Point:**	**Aft left corner**
Container/Item:	**Reaper Wings**	**Drop Height:**	**12 inches**

V. Angle: 65.27;H.Angle: 170.13; Filter: = 110 Hz



	Ch.	Time	Curr Amp	Peak Amp	1st Int	Time/Div	Hexp	Vexp
○	1	1.20 S	0.04 g's	-3.49 g's	-27.00 In/s	131 mS	1	2
○	2	1.20 S	-0.08 g's	-3.43 g's	-33.24 In/s	131 mS	1	2
●	3	1.20 S	0.01 g's	-8.28 g's	-12.56 In/s	131 mS	1	2
○	R	1.20 S	0.10 g's	8.60 g's	44.63 In/s	131 mS	1	2

Remarks

PEAK Gs X: 3 Y: 3 Z: 8 Peak Gs Resultant: 9. Filtered at 110 Hz.
Accelerometer on center beam of cradle.
Ch.1=X(forward-aft); Ch.2=Y(left-right); Ch.3=Z(vertical).
Ch4=Resultant.

Aft Side = desiccant port end. Ambient temperature/humidity.
ASTM D4169, ASTM D6179. SAE ARP 1967. Accel. S/N 16473.

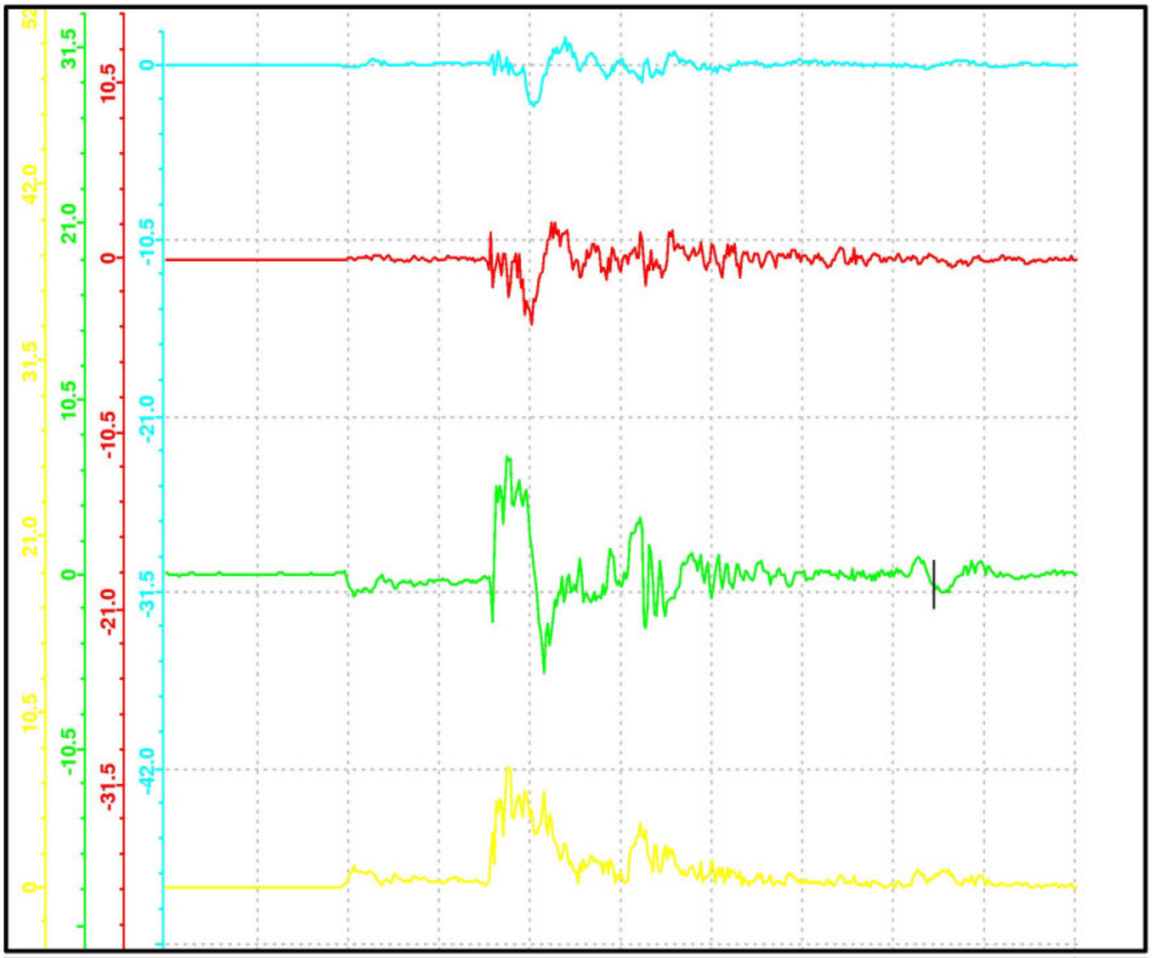
GHI SYSTEMS, INC. CAT SYSTEM

REAPER WINGS

ROTATIONAL DROP TEST

Time:	Dec 19 2007 12:59	Test Engineer:	Evans
Test Type:	Corner	Impact Point:	Aft right corner
Container/Item:	Reaper Wings	Drop Height:	12 inches

V. Angle: 97.29;H.Angle: 284.67; Filter: = 100 Hz



Ch.	Time	Curr Amp	Peak Amp	1st Int	Time/Div	Hexp	Vexp
1	1.10 S	-0.09 g's	-2.57 g's	-4.08 In/s	131 mS	1	2
2	1.10 S	0.17 g's	-3.80 g's	26.54 In/s	131 mS	1	2
3	1.10 S	-0.66 g's	7.46 g's	-2.91 In/s	131 mS	1	2
R	1.10 S	0.69 g's	7.59 g's	27.01 In/s	131 mS	1	2

Remarks

PEAK Gs X: 3 Y: 4 Z: 7 Peak Gs Resultant: 8. Filtered at 100 Hz.
Accelerometer on center beam of cradle.
Ch.1=X(forward-aft); Ch.2=Y(left-right); Ch.3=Z(vertical).
Ch4=Resultant.

Aft Side = desiccant port end. Ambient temperature/humidity.
ASTM D4169, ASTM D6179. SAE ARP 1967. Accel. S/N 16473.

GHI SYSTEMS, INC. CAT SYSTEM

APPENDIX 4: Test Instrumentation

PRESSURE TEST EQUIPMENT - Test sequences 1 & 2

EQUIPMENT	MANUFACTURER	MODEL	SN	CAL. DATE
Digital Manometer	Yokogawa	2655	82DJ6001	Jun 07
Digital Manometer	Yokogawa	2655	82DJ6009	Jul 07

ROUGH HANDLING TEST EQUIPMENT - Test sequence 3

EQUIPMENT	MANUFACTURER	MODEL	SN	CAL. DATE
Shock Amplifier	Endevco	2775A	ER34	NA
Shock Amplifier	Endevco	2775A	ER33	NA
Shock Amplifier	Endevco	2775A	EL81	NA
Item Accelerometer	Endevco	2228C	16473	Sep 07
Data Acquisition	GHI Systems	CAT	Ver. 2.7.1	N/A

APPENDIX 5: Distribution List

DISTRIBUTION LIST

DTIC/O
DEFENSE TECHNICAL INFORMATION CENTER
FORT BELVOIR VA 22060-6218

591 SCMG/CL
WRIGHT-PATTERSON AFB OH 45433-5540

403 SCMS/CL
WRIGHT-PATTERSON AFB OH 45433-5540

418 SCMS/GULAAA (ATTN: THELMA LOOCK)
7973 UTILITY DR.
BLDG. 1135
HILL AFB UT 84056

420 SCMS/GUMAA (ATTN: CAROL BAXTER)
7701 ARNOLD ST.
BLDG. 1, RM 112
TINKER AFB OK 73145

406 SCMS/GUMA (ATTN: WAYNE OSBORN)
375 PERRY ST.
BLDG. 255
ROBINS AFB GA 31098

658 AESS/LG (ATTN: GERALD WILLIAMS)
2640 LOOP ROAD WEST
WRIGHT-PATTERSON AFB OH 45433-5540

GENERAL ATOMICS
ATTN: DAVID LEVY
16761 VIA DEL CAMPO CT
SAN DIEGO, CA 92127

APPENDIX 6: Report Documentation

REPORT DOCUMENTATION PAGE

Form Approved OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*
06-03-2008

2. REPORT TYPE
Technical, Final Project Report

3. DATES COVERED *(From - To)*
March 2006 – June 2008

4. TITLE AND SUBTITLE
Development of the MQ-9 Reaper Wings Container

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)
Matthew P. Bozzuto, Project Engineer
matthew.bozzuto@wpafb.af.mil, DSN 787-7166, Comm. (937)257-7166

Susan J. Evans, Qualification Test Engineer
susan.evans@wpafb.af.mil, DSN 787-7445, Comm. (937)257-7445

5d. PROJECT NUMBER
06-P-106

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Air Force Packaging Technology and Engineering Facility
403 SCMS/GUEB
5215 THURLOW ST, STE 5, BLDG 70C
WRIGHT-PATTERSON AFB OH 45433-5540

8. PERFORMING ORGANIZATION REPORT NUMBER
08-R-08

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution is unlimited.

13. SUPPLEMENTARY NOTES

14. ABSTRACT
The Air Force Packaging Technology & Engineering Facility (AFPTEF) was tasked with the design of a new shipping and storage container for the MQ-9 Reaper wings in March of 2006. The previous container did not adequately satisfy user needs and Air Force requirements. A main problem was that it was designed for an MQ-9 Reaper fuselage, wings, and tails combined, which exceeded the 10,000 lb Air Force requirement for available ground support equipment. AFPTEF designed a smaller container for only the wings and tails and a separate container for the fuselage in order to bring container weights down under the 10,000 lb upper limit. Both containers feature retractable casters for rapid C-130 deployment and easier handling. The wings container features a wire rope isolator mounted cradle system to protect the wings and tails (20G fragility). The new container, CNU-699/E, designed with SAE ARP1967A, is an aluminum, long-life, controlled breathing, reusable shipping and storage container. CNU-699/E protects the MQ-9 Reaper wings and tails mechanically and environmentally and has passed all qualification tests per ASTM D4169.

15. SUBJECT TERMS
CNU-699/E, Predator, MQ-9, Wings Container, Aluminum Container, Reusable Container, Design, Test, Long-life

16. SECURITY CLASSIFICATION OF: a. REPORT	b. ABSTRACT	c. THIS PAGE	17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
U	U	U	UU	37	Matthew P. Bozzuto
					19b. TELEPHONE NUMBER *(Include area code)* (937)257-7166

Standard Form 298 (Rev. 8/98)
Prescribed by ANSI Std. Z39.18